vious days had strongly shown the advantage of separating the parties as much as possible. We chose a spot to leeward of one of the enormous water tanks of the Union Pacific Railway, which form the chief features in the interesting but desolate plains in that region, over which the wind sweeps at times with incredible violence.

On reaching our destination we found Prof. Newcomb, whose camp was about a mile away, and it was then agreed that as both he and Prof. Watson were to hunt for the planet they had better be together, so I lost his company during the eclipse.

Prof. Watson's plan of operation was to sweep south of the sun and observe all the stars in the map, a part of which is here reproduced (Fig. 6), and to refer the position of any new body to the stars, or, if possible, to the sun itself. For this purpose, with the assistance of the Rawlins carpenter, he armed his equatorial with paper circles and brass wire pointers. He commenced operations to the left of the sun and saw the stars marked, but none others. Then sweeping out to the star marked *b* he noticed on his return another not on the chart, marked *a*. He then made three marks on his right ascension paper circle, on the spots occupied by the pointer, when the sun, *a* and *b*, were successively brought into the centre of the field. He next determined the difference of declination in the same way between the sun and *a*, having the additional help that *a* was nearly in the same declination as *b*. He then repeated his R.A. measures, and called Prof. Newcomb, but the eclipse was over before anything more could be done. I give this statement from memory only (as I was too busy to make notes at the time), as I heard it soon after the eclipse at the camp, before the telescope was dismounted. It is probable that subsequent careful measures of the circles may alter the place—

R.A. 8h. 26m.
Dec. + 18° 00′

I telegraphed to you, somewhat, but the alteration will be small.[1]

Since arriving here I have learned that Mr. Swift, of Rochester, a well tried observer, also saw the planet. The first account I read of his work was as follows:—

"This gentleman made a very careful search for Vulcan, scanning the heavens very closely with his splendid comet eye-piece, made by the celebrated Gundlach, but he saw nothing of it. He did, however, see, about three degrees from the sun, two stars not down in the charts or star maps, and about as bright as the pole star—they were pointing directly towards the sun. On attempting to re-find them, he was prevented by a little cloud."

Since then, however, another fuller account of his work has appeared, from which I gather that about one minute after the commencement of totality two stars caught his (Mr. Swift's) eye about three degrees, by estimation, south-west of the sun. He saw them twice, and attempted a third observation, but a small cloud obscured the locality. The stars were both of the fifth magnitude, and but one is on the chart of the heavens. This star he recognised as Theta in Cancer. The two stars were about eight minutes apart. There is no such configuration of stars in the constellation of Cancer. In 1859 the French astronomer, Lescarbault, claimed that he had seen an intra-Mercurial planet crossing the sun's disc. He related his discovery to Leverrier, who became a firm believer in the existence of such a planet. The perturbations of Mercury's orbit demand such a planet as Leverrier named Vulcan. The star Mr. Swift saw may have been the same that was seen by Prof. Watson, who was located at Rawlins, Wy. T.

Mr. Swift possessed a comet eye-piece of very flat and large field, and distinct to the very edge. It was made in Rochester, and to it and his blunder in failing to untie his instrument, he believes he owes his success.

The instrument used in the search for Vulcan by Prof. Holden proved to be inadequate to show all the stars on the Washington star map, owing to the brightness of the corona. The space where the planet seen by Prof. Watson was, was four times swept over, but so near to the sun as this, a four and a-half magnitude star was not to be seen. A space of 10° in declination by 35° in right ascension was twice swept over.

Here, again, we get an idea of the thoroughness with which the work has been planned and executed.

It would be wrong to conclude these hurried notes without stating that, from the day in which I landed in New York to the present time, I have become everybody's debtor for acts of kindness, which have touched me greatly. This great country is a land of true courtesy, for which I here express my gratitude, not only to my scientific brethren, and chiefly to Dr. Draper, General Myer, and Prof. Newcomb, whose guest I have been, but to hundreds to whom I have been a stranger and unknown.

As significant of the keen interest taken in the eclipse by all classes here, I may mention, in conclusion, that on the Sunday before the event prayers for fine weather were offered in all the churches of Denver.

Washington, D.C., Aug. 8 J. NORMAN LOCKYER

AS I have been recently giving attention to the subject of solar spectroscopy in consequence of my discovery of oxygen in the sun, it seemed desirable to take advantage of the total eclipse of July 29, to gain as precise an idea as possible of the nature of the corona, because the study of that envelope has been regarded as impossible at other times. The main point to ascertain was whether the corona was an incandescent gas shining by its own light, or whether it shone by reflected sunlight.

For this purpose I organised an expedition, and was fortunate enough to secure the co-operation of my friends Professors Barker and Morton, and Mr. Edison. The scheme of operation was as follows: (1) the photographic and photo-spectroscopic work, as well as the eye slitless spectroscope were to be in charge of my wife and myself; (2) the analysing slit spectroscope was in charge of Prof. Barker, with the especial object of ascertaining the presence of bright lines or else of dark Frauenhofer lines in the corona; (3) the polariscopic examinations were confided to Prof. Morton, who was also to spend a few moments in looking for bright or dark lines with a hand spectroscope; (4) Mr. Edison carried with him one of his newly-invented tasimeters with the batteries, resistance-coils, Thomson's galvanometer, &c., required to determine whether the heat of the corona could be measured.

This entire programme was successfully carried out,

[1] On going to press we receive a letter from Prof. Watson, dated Ann Arbor, August 14, stating that the result of more careful examination gives —Washington M.T., July 29, 5h. 16m., R.A, 8h. 26m. 54s., Dec. + 18° 16′.

and good fortune attended us in every particular. The results obtained were: (1) the spectrum of the corona was photographed and shown to be of the same character as that of the sun, and not due to a special incandescent gas; (2) a fine photograph of the corona was obtained, extending in some parts to a height of more than twenty minutes of arc, that is, more than 500,000 miles; (3) the Frauenhofer dark lines were observed by both Professors Barker and Morton in the corona; (4) the polarisation was shown by Prof. Morton to be such as would answer to reflected solar light; (5) Mr. Edison found that the heat of the corona was sufficient to send the index beam of light entirely off the scale of the galvanometer. Some negative results were also reached, the principal one being that the 1474 K, or so-called corona, line was either very faint or else not present at all in the upper part of the corona, because it could not be observed with a slitless spectroscope, and the slit spectroscope only showed it close to the sun.

The general conclusion that follows from these results is that on this occasion we have ascertained the true nature of the corona, viz., it shines by light reflected from the sun by a cloud of meteors surrounding that luminary, and that on former occasions it has been infiltrated with materials thrown up from the chromosphere, notably with the 1474 matter and hydrogen. As the chromosphere is now quiescent this infiltration has taken place to a scarcely perceptible degree recently. This explanation of the nature of the corona reconciles itself so well with many facts that have been difficult to explain, such as the low pressure at the surface of the sun, that it gains thereby additional strength.

The station occupied by my temporary observatory was Rawlins (lat. 41° 48′ 50″, long. 2h. om. 44s. W. of Washington, height 6,732 feet above the sea), on the line of the Union Pacific Railroad; because, while it was near the central line of totality, it had also the advantages of being supplied with water from the granite of Cherokee mountain, and of having a repair shop, where mechanical work could be done. I knew by former experience that the air there was dry and apt to be cloudless; in this particular our anticipations were more than fulfilled by the event, for the day of totality was almost without a cloud and the dew-point was more than 34° F. below the temperature.

The instruments we took with us were as follows, and weighed altogether almost a ton:—1st. An equatorial mounting, with spring governor driving clock, lent by Prof. Pickering, Director of Harvard Observatory. 2nd. A telescope of 5¼ inches aperture and 78 inches focal length, furnished with a lens specially corrected for photography, by Alvan Clark and Sons. 3rd. A quadruple achromatic objective of 6 inches aperture and 21 inches focal length, lent by Messrs. E. and H. T. Anthony, of New York. To this lens was attached a Rutherfurd diffraction grating nearly 2 inches square, ruled on speculum metal. The arrangement with its plate-holders, &c., will be designated as a phototelespectroscope. 4th. A 4-inch achromatic telescope with Merz direct vision spectroscope, brought by Prof. Barker from the collection of the University of Pennsylvania. 5th. A 4-inch achromatic telescope, also brought by Prof. Barker; to it was attached Edison's tasimeter. Besides these there were polariscopes, a grating spectroscope, an eye slitless spectroscope with 2-inch telescope, and finally, a full set of chemicals for Anthony's lightning collodion process, which, in my experience, is fully three times quicker than any other process.

The arrangement of the phototelespectroscope requires further description, for success in the work it was intended to do, viz., photographing the diffraction spectrum of the corona, was difficult, and, in the opinion of many of my friends, impossible. In order to have every chance of success it is necessary to procure a lens of large aperture and the shortest attainable focal length, and to have a grating of the largest size adjusted in such a way as to utilise the beam of light to the best advantage. Moreover, the apparatus must be mounted equatorially and driven by clockwork, so that the exposure may last for the whole time of totality, and the photographic work must be done by the most sensitive wet process. After some experiments during the summer of 1877 and the spring of 1878 the following form was adopted:—

The lens being of 6 inches aperture and 21 inches focal length, gave an image of the sun less than ¼ of an inch in diameter and of extreme brilliancy. Before the beam of light from the lens reached a focus it was intercepted by the Rutherfurd grating set at an angle of 60 degrees. This threw the beam on one side and produced there three images—a central one of the sun, and on either side of it a spectrum; these were received on three separate sensitive plates. One of these spectra was dispersed twice as much as the other, that is, gave a photograph twice as long. This last photograph was actually about two inches long in the actinic region. If now the light of the corona was from incandescent gas giving bright lines which lay in the actinic region of the spectrum, I should have procured ring-formed images, one ring for each bright line. On the other hand if the light of the corona arose from incandescent solid or liquid bodies, or was reflected light from the sun, I was certain to obtain a long band in my photograph answering to the actinic region of the spectrum. If the light was partly from gas and partly from reflected sunlight, a result partly of rings and partly a band would have appeared.

Immediately after the totality was over and on developing the photographs, I found that the spectrum photographs were continuous bands without the least trace of a ring. I was not surprised at this result because during the totality I had the opportunity of studying the corona through a telescope arranged in substantially the same way as the phototelespectroscope, and saw no sign of a ring.

The plain photograph of the corona taken with my large equatorial (exposure 150 seconds) on this occasion shows that the corona is not arranged centrally with regard to the sun. The great mass of the matter lies in the plane of the ecliptic but not equally distributed. To the eye it extended about a degree and-a-half from the sun toward the west, while it was scarcely a degree in length toward the east. The mass of meteors, if such be the construction of the corona, is therefore probably arranged in an elliptical form round the sun.

For the fortunate results of this expedition we are not a little indebted to the railroad and express companies. The Pennsylvania, the Chicago and North-western, and the

Union Pacific railroads, the Pullman Palace-Car Company, and the American and Union Pacific Express companies made the most liberal arrangements, and Mr. Galbraith, the superintendent of the Repair Works at Rawlins, gave us the free use of his private house and grounds. Of the citizens of Rawlins it is only necessary to say that we never even put the lock on the door of the observatory, and not a thing was disturbed or misplaced during our ten days' residence, though we had many visitors. They sent us away with a serenade. HENRY DRAPER

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Floating of Solid on Molten Metal

I OBSERVE in NATURE (vol. xviii. p. 397) a note of some experiments on this subject. The results of these experiments (unless with lead) are, I think, very similar to some which I have made, and described in your pages (see NATURE, vol. xvi. p. 23), viz., that with *heavy pieces* the metal first *sank* and then *rose to surface;* with light pieces the "skin" formed on the surface of the ladle was sufficient to keep them afloat. From these experiments I drew the conclusion that the cold solid metal was specifically *heavier* than the molten metal, but after a short immersion, depending on size of pieces, these pieces had *expanded* by the great heat around them so as to have *their bulk increased sufficiently* to enable them to float. My experiments with solid pieces of lead showed that they *sank* and did not come to the surface, and could be felt lying at bottom. Pieces of sheet lead rolled up floated.

In some recent experiments which I made, I found that *cold* pieces of steel rails placed in a furnace of molten steel sunk at first and floated afterwards, but that *hot pieces floated*, and did not sink. W. J. MILLAR

100, Wellington Street, Glasgow, August 10

A Meteorite ?

THIS day, at 12.15 P.M., I was considerably startled by what was to me a remarkable phenomenon. The weather had been very "thundery" all the morning, and heavy rain was falling in torrents. I sat at my desk by a window looking out upon a court inclosed by high walls. Chancing to look out of the window I heard a sharp report, just like the crack of a Snider rifle sounding immediately outside, followed instantaneously by the descent of a ball of fire about the size of an ordinary gas-lamp globe. This fell vertically and with lightning speed, but when just on a line with the centre of my window burst into a splendid mass of rays, whitish-blue in colour, and of dazzling brilliancy. That is all I can tell you about it. Every one in the house heard the report, and quite a temporary panic ensued. No material effect of the meteorite's presence can be found.

Perhaps some of your readers may be able to explain the phenomenon. J. HARRIS STONE

67, Chandos Street, Strand, August 23

The Australian Monotremes

THE *Tachyglossus* was shot by me near Georgetown, in lat. 18° S. I have found it inhabiting the porphyritic ranges (Newcastle and Mount Turner) in this locality, where they are rather numerous. In my letter (NATURE, vol. xvi. p. 420) I should have written "integumentary" pouch. The *Orinthorhynchus paradoxus* I saw floating with its bill above water in a lagoon between Georgetown and Normanton, 150 miles west of the former town.

Owing to the noise made by my detachment in riding up, I was unable to capture this specimen, but I do not despair of securing one on my next trip westward. I certainly believe the *Tachyglossus* extends throughout the length of the Cape York peninsula on the east, and through the Gregory, Leichhardt, and Cloncurry ranges to the southward and south-westward of Georgetown. Its habit of burrowing beneath rocks precludes the possibility of its occurrence on the Lower Gilbert and Flinders River plains.

"P. L. S." will find my "notes" on this subject in the Linnæan Society's *Journal*, as I sent them, accompanied by the skull of an adult female, to the Society in March last.

Georgetown, June 1 W. E. A.

Microphone in Indirect Circuit

IT is not absolutely necessary that the microphone should form part of the direct circuit. It works just as well if connected so that, when the carbons are not touching, the whole of the current goes through the telephone. When the carbons are together a small portion will of course leak through them; upon this leakage depends the rise and fall of tension in the receiver. For some experiments it is even better to work the microphone in this indirect manner, as the circuit always remains closed, and prevents, in a great measure, the *jarring* noise resulting from a break. ALFRED CHIDDEY

Bristol Mining School, August 19

OUR ASTRONOMICAL COLUMN

THE SATELLITE OF NEPTUNE.—We here present in a tabular form the means of determining the approximate position and distance of the satellite of Neptune, with respect to the primary for any time during the months of September and October, or indeed by extending the epochs subjoined, for any time during the present opposition. The argument u is the distance of the satellite from the ascending node of the orbit upon the earth's equator, and $u = 0°$, at these Greenwich mean times :—

	h.	m.		h.	m.
Sept. 4 ...	18	38·3	Oct. 4 ...	3	52·0
,, 10 ...	15	41·0	,, 10 ...	0	54·7
,, 16 ...	12	43·8	,, 15 ...	21	57·5
,, 22 ...	9	46·5	,, 21 ...	19	0·2
,, 28 ...	6	49·3	,, 27 ...	16	3·0

The motion of u in one day is 61°·257, in one hour 2°·552, and in one minute 0°·0425. Having determined the value of u from these epochs and motions for the proposed time of observation, the angle of position and distance of the satellite from the centre of the planet may be taken from the following table, in which the first and second columns of angles apply to the respective columns of the argument u :—

Arg. u.		Angle of position.		Distance.	Arg. u.		Angle of position.		Distance.
°	°	°	°	″	°	°	°	°	″
0	180	71·6	251·6	9·8	90	270	29·8	209·8	15·0
10	190	63·1	243·1	11·7	100	280	25·0	205·0	13·6
20	200	56·9	236·9	13·5	110	290	18·9	198·9	11·8
30	210	52·0	232·0	14·9	120	300	10·6	190·6	9·9
40	220	48·0	228·0	16·0	130	310	358·2	178·2	8·0
50	230	44·3	224·3	16·7	140	320	338·9	158·9	6·4
60	240	40·9	220·9	17·0	150	330	311·7	131·7	5·8
70	250	37·5	217·5	16·8	160	340	284·2	104·2	6·4
80	260	33·8	213·8	16·1	170	350	264·4	84·4	7·9
90	270	29·8	209·8	15·0	180	360	251·6	71·6	9·8

The period of revolution of the satellite is 5d. 21h. 2·74m., and by successive additions of this period the epochs may be continued for November or later.

As an example of the application of the table, suppose it is desired to know the approximate position of the satellite on September 14 at Greenwich midnight. Strictly the time for aberration should be deducted, which, in minutes, is given by [0·9189] × log. distance of Neptune from the earth—this log. distance being taken from p. 269 of the *Nautical Almanac*. In the present case we find 4h. 1·9m. to be deducted from 12h., so that